

SPECIAL PROVISIONS & PLANS
FOR RECONSTRUCTION OF 18.5 FOOT DIAMETER CULVERT

STATION 130 + 61.7
LYONS CREEK SOUTH PROJECT
1 15-4 (18) 210 U-1

PREPARED FOR
MONTANA HIGHWAY COMMISSION

MARCH 30, 1965

PREPARED BY
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HELENA, MONTANA



SPECIAL PROVISIONS

FEDERAL AID PROJECT NO. 1 15-4 (18) 210 UI
LYONS CREEK SOUTH

RECONSTRUCTION OF 18.5 FOOT DIAMETER CULVERT

1. GENERAL: In addition to the applicable portions of the Standard Specifications for Road and Bridge Construction and the applicable portions of the Special Provisions for the original work, the reconstruction of the 18.5 foot diameter metal pipe shall be done in accordance with the following special provisions which shall supplement and/or supercede them.

Where reference is made to the 3/8" plate portions of the pipe, it refers to the inner 328 foot length which is made up of 3/8" plate for the whole pipe circumference.

2. SUB-CONTRACTOR: The actual reconstruction of the metal pipe (not earth-work) will be done by the Armco Steel Corporation, Metal Products Division, sub-contractor to the prime contractor for the original and reconstructed metal pipe culvert.

3. JOINT INVESTIGATION & REDESIGN: The Armco Steel Corporation has conducted an extensive investigation of the factors involved in the 1964 pipe failure. This investigation has included a vast amount of physical testing to evaluate the joint design previously used and to assure a proper redesign of the joint. The conclusion of the Armco Steel Corporation regarding the joint failure after extensive investigation is that the joint failure was caused primarily by the extreme overtightening of the 3/4 inch diameter ASTM 354-BD bolts used for the heavier 3/8" plate portion of the culvert. The lesser ductility of the very high strength bolt may have contributed to the bolt failures. Being guided by their extensive testing and analysis of the problem, the Armco Steel Corporation has recommended reconstruction of the culvert using 7/8 inch diameter ASTM 325 bolts for all the 3/8" plate portion of the pipe. The State of Montana, after considering their own and their consulting engineers evaluation of the joint failure, but relying primarily on the extensive investigations of the pipe manufacturer, have accepted the Armco Steel Corporation's recommendations and proposal for reconstruction of the metal pipe. The Armco Steel Corporation, having recently completed the major portion of their testing on this problem, will at an early date submit a written report to the State of Montana describing the tests and other investigations performed and substantiating the joint design recommended for the reconstruction work.

4. REMOVAL OF DAMAGED PLATES AND REUSE OF APPARENTLY UNDAMAGED PLATES: The Contractor shall remove all damaged sections of pipe and replace them with new plates rolled to the same radius as the original plates. Exactly which plates will be replaced and which will be reused will be determined by inspection in the field. However, all plates considered unsatisfactory to the State shall be replaced. Plates with torn holes will be considered unsatisfactory for reuse. Plates deformed from their original shape will not be reused. Plates with seriously elongated holes will not be reused. All reused



and replaced pipe sections shall fit solidly together with bolted connections seating properly throughout the length of the longitudinal and circumferential joints. The Armco Steel Corporation shall check the diameters of the pipe as it is reassembled with assistance from the State Inspector. Some shortening of the original vertical diameter and some lengthening of the horizontal diameter may be expected. The original inside vertical diameter before backfilling was apparently between 19'- 7" and 20'- 1". The original inside horizontal dimensions was apparently between 17'- 2" and 17'- 8". If the reconstructed pipe prior to backfill results in a shape not falling within these limits, special consideration of the deformed shape shall be given and the State's approval or disapproval secured before proceeding with the work. If a shape deformed more than the limits above is disapproved by the State, Armco Steel Corporation shall replace or relocate sufficient plates to achieve an acceptable shape of the pipe prior to backfill. In any event the pipe cross section shall be essentially uniform with no points seriously distorted from a true elliptical shape and all plates not suitable for achieving uniformity shall be removed and replaced.

5. NEW BOLTS: All bolts in the 3/8" plates of the original pipe shall be replaced with 7/8 inch diameter ASTM 325 bolts. All new bolts shall be of the proper length for the thickness of plates being joined. Bolts and nuts shall be galvanized to meet the current ASTM A153 specification. The galvanizing on the threaded portion of the bolts shall not prevent turning the nut by hand. Nut threads shall be cleaned after galvanizing to provide a free running fit on the Class 2 bolts.

The Armco Steel Corporation shall provide certifications for the new ASTM 325 bolts to show that the bolt manufacturer certifies the bolts provided do meet the specification. If requested by the State, the contractor shall provide a sampling of the bolts to the State for the State's analysis and testing.

6. REAMING FOR NEW BOLTS: Existing plates to be reused shall have the bolt holes accurately and concentrically reamed, without damage to the plates, to a hole size not larger than one inch in diameter. It is assumed that the new plates have been punched for 7/8" diameter bolts and will require no reaming. However, if new plates have been punched for 3/4" diameter bolts in the longitudinal seams, the bolt holes shall be reamed at the job site to receive the 7/8" diameter bolts.

7. SEQUENCE OF PIPE RECONSTRUCTION: The pipe reconstruction shall be carried out in a suitable manner to achieve the required bedding and backfill around the pipe. The contractor will be permitted to excavate a transverse trench in the pipe bedding to permit bolting the circumferential joints of adjoining sections of the pipe bottom. After bolting, the trench shall be carefully filled and compacted with pneumatic hand tampers to the specified backfill material density using material as specified for the balance of the pipe bedding. The pipe above the bedding where bolts may be reached for insertion and tightening may be reconstructed in any logical sequence acceptable to the Armco Steel Corporation and to the State.



8. BOLT TIGHTENING EQUIPMENT: The contractor will be permitted to use approved impact wrenches for the new bolting work. The wrenches and equipment used must provide for positive torque control either by a torque control mechanism on the wrench or by a positive method of regulating the air pressure on the wrenches at a uniform level and at any given pressure required to produce the desired bolt tension.

If air pressure control is used, the equipment shall include one or more suitable air regulators which can be quickly adjusted to maintain any desired pressure. The compressor shall be of adequate capacity to handle the number of wrenches in use. A large air storage reservoir is strongly recommended. The wrenches shall not be operated unless the proper pressure to each wrench is being maintained. At any time that the compressor cannot maintain a constant pressure to the wrenches being operated, the number of wrenches in use shall be reduced until the pressure can be maintained constant. If different wrenches require a different pressure to achieve the required bolt tension, sufficient air regulators shall be provided to properly control each wrench.

Wrenches with torque control mechanisms shall be easily adjustable to any desired torque value. They shall maintain the setting accurately when set and shall uniformly tension the bolts.

Any wrenches which in the States opinion fail to uniformly tension the bolts shall not be used. The wrenches shall perform the required tightening of each bolt in approximately ten seconds.

9. BOLT TENSION CALIBRATING EQUIPMENT: Armco Steel Corporation shall provide an approved bolt tension calibrator to accurately control the adjustment of the wrenches for the bolting work. It is suggested a Skidmore-Wilhelm, Model M, bolt tension calibrator with special adapters for the Armco bolts be used. The tension calibrator shall provide for the insertion of the bolt in the calibrator with a galvanized washer. The equipment will provide for tightening the nut or bolt head against the galvanized washer to simulate the tightening situation in the field. The bolt calibrator shall accurately measure the actual bolt tension.

10. TORSION WRENCH: The State shall provide a torsion wrench with extension handle to measure the torque in tightened bolts. The wrench will have a capacity of 500 foot pounds of torque.

11. BOLTING PROCEDURE: The following procedure shall be followed in the new bolting work.

- (a) Calibration of Wrenches. The bolt tension calibrator shall be set up by the contractor close to the location of the bolting. The wrenches to be used shall be connected to the equipment in the manner in which they are to be used. Care shall be taken to have the hoses of the length to be used connected to the wrenches. Each wrench shall be adjusted using the calibrator by tightening not



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less than three bolts in the calibrator. The last two bolts of each test group shall tension the bolt within ten percent of the required bolt tension. The bolt tension to be used initially shall be as follows. (The desired bolt tension has been arbitrarily taken at 70% of the proof load of the bolt).

<u>Bolt Size</u>	<u>Desired Bolt Tension</u>	<u>Max.</u>	<u>Min.</u>
3/4" diam.	20,000 Pounds	18,000	22,000
7/8" diam.	25,000 Pounds	22,500	27,500

If the above requirements (Desired Bolt Tension) result in over 250 foot pounds of torque on the bolts as measured by the State, special consideration shall be given to reducing the bolt tension. A galvanized washer shall be used under the nut or bolt head being tightened to simulate the field condition. The nut or bolt head shall be turned by the wrench during the test the same as the bolting work requires that is in progress. Several of the final bolts tested shall be checked with the State's torque wrench to determine the torque required to produce the desired tension.

At the start of the work each wrench in use shall be checked in the bolt tension calibrating equipment at least once each four hours. Throughout the bolting, each wrench shall be checked with the calibrator each time the equipment arrangement is altered, such as after adding hose lengths to the wrenches. If it is found more frequent checking of the wrenches than every four hours is required to maintain proper control, the wrenches shall be checked more often. If, after gaining experience using the calibrator, the contractor and the State are both satisfied that checking less frequently will maintain adequate control, the general checking in the calibrator may be reduced to once each eight hour shift.

The Armco Steel Corporation shall provide an adequate supply of galvanized plate washers for testing. If it can be shown one washer may be used for several tests without altering the results as compared to an unused washer, the washers may be reused. However, if a new washer is required for each test to achieve accurate results, washers shall not be reused.

The calibrating equipment shall at all times be operated in accordance with the manufacturer's recommendations. The contractor shall organize and carry out the regular calibration of his equipment under the general surveillance of the State.

- (b) Bolting. The pipe sections shall be assembled and holes reamed as previously discussed. Bolts shall then be installed generally in a manner that will permit tightening of the nuts. With wrenches set to properly control the torque and bolt tension, all bolts for a given section of pipe shall be tightened and the adjoining plate sections installed. Two or more passes, as necessary, over the bolts in the previously tensioned section shall then be made to achieve uniform tightening to the desired tension.



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- (c) Testing Tightened Bolts & Correcting Improperly Tightened Bolts. The State will check at least twenty percent of the bolts in each joint. The torque required to cause the nut to move shall be within 50 foot pounds of the torque required to produce the desired bolt tension. The State will regularly measure the torque on several bolts tensioned properly in the bolt tension calibrator to determine the correct torque value for each condition of bolting. The torque value so determined will be used to judge the bolting for each portion of the work. The State Inspector will keep a record of the torque values determined and used as the work progresses.

When bolts are found torqued more than 50 foot pounds above or below the desired value, all bolts shall be tested for the joint in question. Any loose bolts shall be tightened. Bolts torqued over 50 foot pounds above the desired torque value shall be removed, replaced and the new bolts properly tightened.

12. CHECKING BOLTING OF PIPE ADJACENT TO 3/8" PLATE: The contractor shall assist the State Inspector in checking some of the bolting in the No. 1 Gage pipe adjacent to the 3/8" plate sections. A portion of the 3/4" ASTM 325 bolts shall be checked to determine the torque to move the nut. A few of these bolts shall be removed and tightened in the bolt tension calibrator to the average existing torque value noted and the bolt tension determined. This data shall be considered by the State.
13. FINAL RESPONSIBILITY FOR BOLTING: The contractor shall be finally responsible for all bolts being properly tensioned. The work shall be carried out in a manner so that the bolt tension calibrating equipment is used to improve the uniformity and correct tensioning of bolts. Care shall be taken to carry out the bolting work carefully and not to assume the bolt tension calibrating equipment in any way reduces the need for careful workmanship in the actual bolting work. The State's inspection shall not in any way reduce the contractor's responsibility for completing the work with properly tensioned bolts throughout.
14. RECONSTRUCTION PLACEMENT CONTROL DEVICES: The plumb bob hangars on the top of the culvert and the reference pins and protecting 15" vertical pipes on the bottom of the culvert shall be restored to their original condition for use in checking the pipe alignment during backfill.



15. BACKFILL MATERIAL - ITEM #6210: All backfill material under this item shall be compacted to a minimum of 95% of maximum density as determined by AASHTO T-99, Method D and AASHTO T-147. Optimum moisture content shall be maintained within plus or minus 15% as determined by AASHTO T-99, Method D. Gradation of material shall be as follows:

<u>Sieve</u>	<u>Passing</u>
1½"	100%
¾"	67 - 82
3/8"	37 - 55
# 10	13 - 27
# 40	7 - 18
#200	4 - 12

The maximum limit to be used in computing the quantity for payment shall be the dimensional limits for Backfill Material shown on Section A-A of Drawing No. 275-05-50-1. However, within these limits payment will not be made for material not removed and replaced under the pipe. Payment will not be made for material not removed and replaced longitudinally along the pipe at both ends.

Each layer of Backfill Material and Embankment Material below the top of the baled organic backfill should extend the full length of the repair area and compaction should be longitudinal to the pipe with each pass extending the length of the layer.

16. PIPE BEDDING: Backfill Material, Item #6210, shall be brought up to the height as detailed above the bottom of pipe with compaction as specified under Backfill Material. Pipe bedding surface shall be cut to fit pipe curvature plus a 4" loose bedding space. Fine grading of bed to receive loose bedding shall conform within ½" plus or minus. Loose bedding shall consist of Backfill Material, Item #6210, placed at a density not to exceed 70% of standard as determined under Item #6210.

17. ORGANIC BACKFILL: Organic backfill shall consist of rectangular shaped bales of straw or hay. Care shall be taken in placing embankment over the organic backfill. Embankment for a depth of 6 feet over the organic backfill shall be placed with a loader or other similar device. No compaction or equipment shall be allowed above the organic backfill until the 6 feet of loose cover is in place.

Upon completion of placing and compacting the embankment material to the top of any layer of baled organic backfill, the baling wires should be cut before proceeding with the next layer.

Organic backfill shall be measured and paid for by the cubic yard in place.



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18. PAINING OF REAMED HOLE SURFACES: All reamed hole surfaces which do not have a hot dip galvanized surface shall be painted with a zinc dust-zinc oxide primer conforming to Federal Specification TT-P-641. The number of coats of primer to be applied shall be such as to provide a dry film thickness of 2 to 3 mils. An external curing agent shall be applied over the primer coatings if required by the particular manufacturers material used.

Prior to painting surfaces must be completely free of rust, moisture, oil, dirt, or any other material or condition which would adversely affect the proper performance of the applied coatings.

The intent of this painting requirement is to provide a permanent abrasion resistant rust proof coating over the surfaces of the culvert bolt holes which do not have a hot dip galvanized coating.

The use of this primer may also be extended to small areas of the corrugated plate surfaces where the galvanized surface is no longer intact. However, this provision is not intended to permit the use of any plates whose re-use has been rejected because of extensive damage to the galvanized surface.

The surface preparation and application of this primer coating shall be in accordance with the manufacturers recommendations and applicable portions of Section 54 of the Standard Specifications.

